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ABSTRACT

This document is one in a series which outlines performance objectives and instructional modules for a course of study which explains the relationships and functions of the process units in a wastewater treatment plant. The modules are arranged in an order appropriate for teaching students with no experience. The modules can also be rearranged and adapted for courses to upgrade personnel moving into supervisory positions or designed as a minicourse. Each module contains a statement of purpose, objectives, conditions, acceptable performance, instructor and student activity. The tasks are organized into the general categories of: normal operation, abnormal operation, preventive maintenance, corrective maintenance, laboratory control, systems interaction and management/supervisory procedures. This volume includes four modules: (1) Treatment Provided by Process Units; (2) Effects of Industrial Wastes on Operations; (3) Relationship of Process Units; and (4) Development of Flow Diagrams. (CS)

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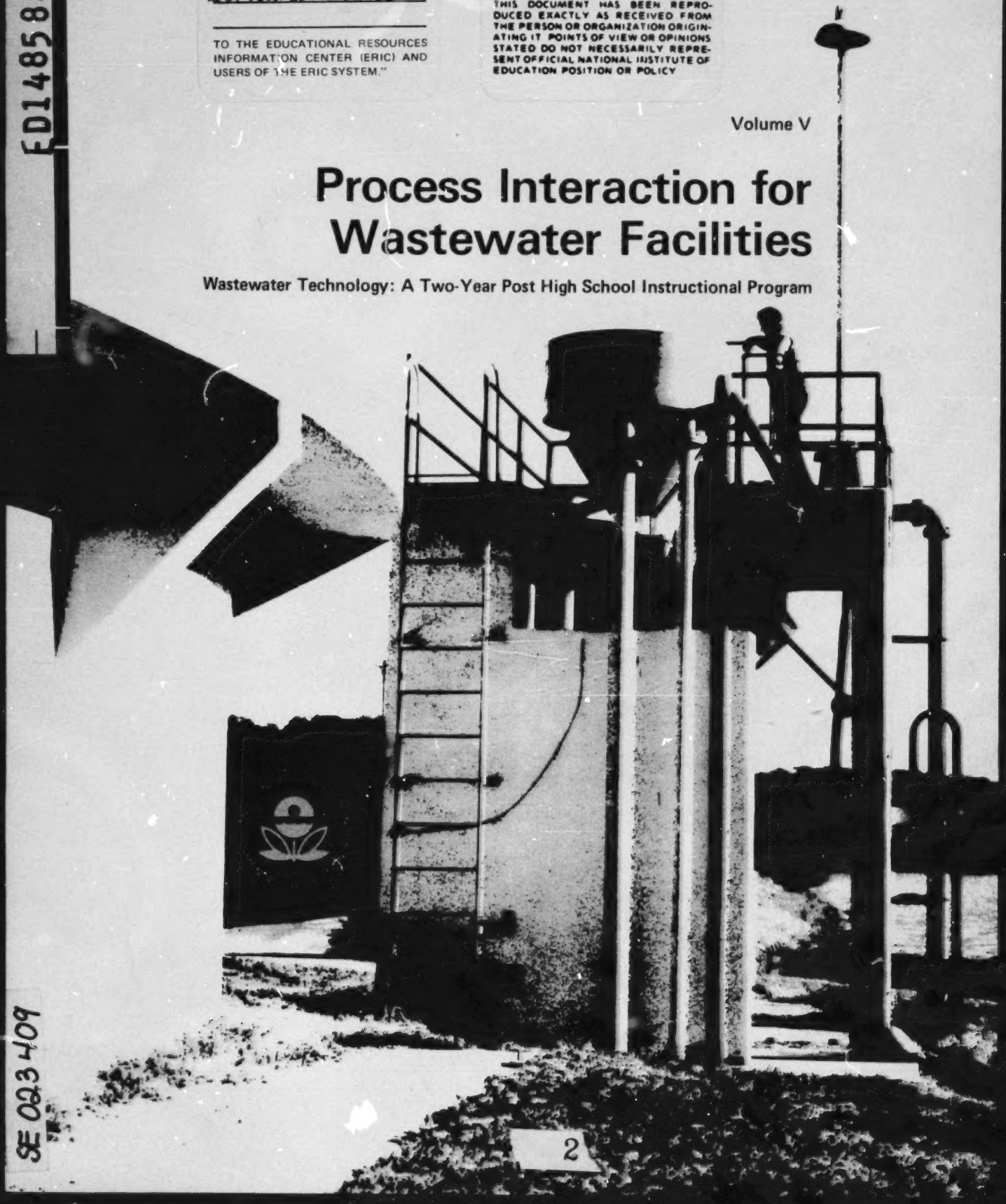
Volume V

Process Interaction for Wastewater Facilities

Wastewater Technology: A Two-Year Post High School Instructional Program



SE 023 409

PROCESS INTERACTION FOR WASTEWATER FACILITIES

An Instructor's Guide for Use of Instructional Material
In Wastewater Technology Training Programs

Funded by

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Preface

Since 1970 Charles County Community College, Clemson University, Greenville Technical College and Linn-Benton Community College have been working together to prepare undergraduate students to enter occupations in water and wastewater treatment plant operations and maintenance. Through their efforts a two-year wastewater technology instructional program based on performance objectives has been developed and implemented.

Through a grant from the Environmental Protection Agency called *Criteria for the Establishment of Two-Year Post High School Wastewater Technology Programs (CEWT)* the four colleges set up program criteria and curriculum guidelines which are available in two volumes:

Program Implementation Procedures
Curriculum Guidelines, Criteria for Establishment and Maintenance of Two-Year Post High School Wastewater Technology Programs

As a result of the implementation of the instructional program at Charles County Community College, Greenville Technical College and Linn-Benton Community College, six guides for instructors based on the course descriptions in *Program Implementation Procedures* and the general criterion behaviors of *Curriculum Guidelines* have been prepared. *Process Interaction for Wastewater Facilities* is the fifth in the series which includes:

Volume I *Introduction to Environmental Technology*
Volume II *Plant Operations for Wastewater Facilities*
Volume III *Laboratory Control for Wastewater Facilities*
Volume IV *Management and Supervision Procedures for Wastewater Facilities*
Volume V *Process Interaction for Wastewater Facilities*
Volume VI *Advanced Waste Treatment*

ACKNOWLEDGEMENTS

Since the beginning of the project many persons at the four cooperating institutions, as well as outside consultants have participated in the development of this program. Their efforts which have provided source material for this guide have been acknowledged in the volumes to which they made major contributions. *Process Interaction for Wastewater Facilities* has been written and produced by:

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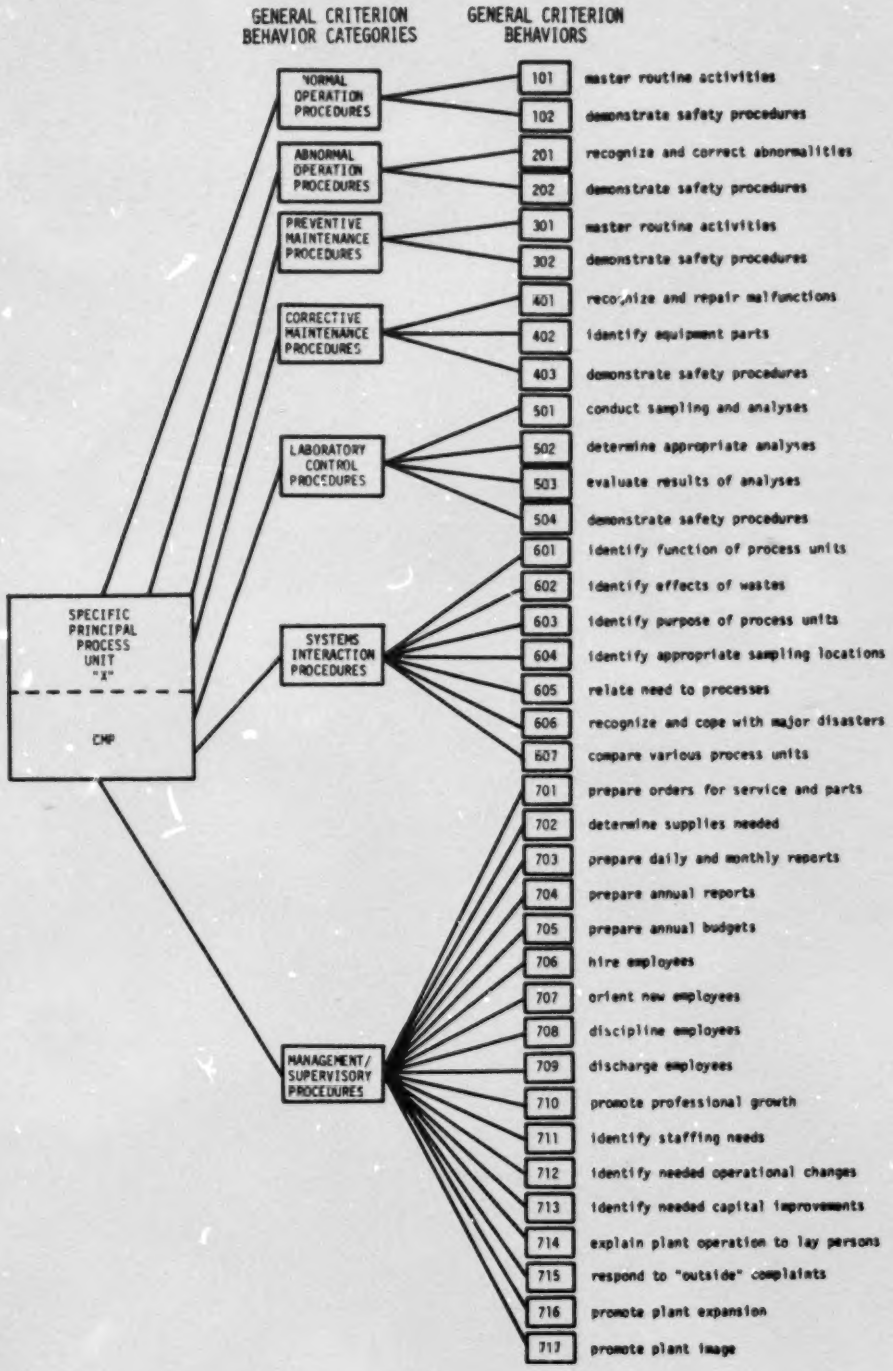
GENERAL CRITERION BEHAVIOR CATEGORIES
GENERAL CRITERION BEHAVIORS
NORMAL OPERATION PROCEDURES
ABNORMAL OPERATION PROCEDURES
PREVENTIVE MAINTENANCE PROCEDURES
CORRECTIVE MAINTENANCE PROCEDURES
LABORATORY CONTROL PROCEDURES
SYSTEMS INTERACTION PROCEDURES
MANAGEMENT/ SUPERVISORY PROCEDURES
SPECIFIC PRINCIPAL PROCESS UNIT "X"
CMP
101 master routine activities
102 demonstrate safety procedures
201 recognize and correct abnormalities
202 demonstrate safety procedures
301 master routine activities
302 demonstrate safety procedures
401 recognize and repair malfunctions
402 identify equipment parts
403 demonstrate safety procedures
501 conduct sampling and analyses
502 determine appropriate analyses
503 evaluate results of analyses
504 demonstrate safety procedures
601 identify function of process units
602 identify effects of wastes
603 identify purpose of process units
604 identify appropriate sampling locations
605 relate need to processes
606 recognize and cope with major disasters
607 compare various process units
701 prepare orders for service and parts
702 determine supplies needed
703 prepare daily and monthly reports
704 prepare annual reports
705 prepare annual budgets
706 hire employees
707 orient new employees
708 discipline employees
709 discharge employees
710 promote professional growth
711 identify staffing needs
712 identify needed operational changes
713 identify needed capital improvements
714 explain plant operation to lay persons
715 respond to "outside" complaints
716 promote plant expansion
717 promote plant image

Figure 1: Relationship of general criterion behaviors (performance objectives) to the general categories and composite model plant (CMP).

Performance Objectives

When the treatment plant operators, educators, consultants and representatives from professional water pollution control organizations came together to develop an effective instructional program, they recommended the use of performance or behavioral objectives because such objectives clearly outline:

1. What the student is expected to do as a result of the instructional program.
2. The conditions under which the student shall do it.
3. The standard of performance.

COMPOSITE MODEL PLANT

First, they developed a composite model plant (CMP) of twenty-two process units which is really many wastewater treatment plants in one model. Such a mix of process units seldom occurs in a treatment plant, but if a student becomes competent in the operation and management of the CMP he should be able to perform successfully in any treatment plant.

TASK ANALYSIS

Next, to ensure that the materials were specifically tailored to what the operator does on the job, a task analysis was conducted. They found that the tasks which an operator performs fell into seven general categories which were further divided into 37 tasks or general behaviors. (See figure 1, page vi.) The tasks were organized under:

1. Normal Operation Procedures. These include routine operating activities that do not vary significantly from day to day and that are designed to keep the plant functioning within a normal range of values. For example, the employee conducts routine samplings of the primary sludge and inspects pumping equipment and the wastestream to verify that the process is functioning properly.

2. Abnormal Operation Procedures. These include activities of the plant employee that result from unusual and undesirable conditions of the wastestream. The abnormal procedures enable the plant employee to recognize when the wastestream is abnormal and to return it to an acceptable, normal condition. An abnormal wastestream results when a normal operation procedure is not properly applied, a corrective maintenance procedure is needed or management/supervisory procedures are poor. For example, the plant employee should recognize that a black septic primary sludge sample is an abnormal condition of the wastestream and take appropriate action.

3. Preventive Maintenance Procedures. These include routine maintenance activities of the plant employee which prevent major equipment breakdown and subsequent corrective maintenance. For example, the employee would lubricate bearings and other moving parts, replace worn components and adjust components of the primary sludge pumps.

4. Corrective Maintenance Procedures. These include maintenance activities of the plant employee that usually result from the breakdown or malfunction of a unit of equipment or a component. For example, the employee would notice whether the primary sludge pump is malfunctioning and know when and how to correct the disorder or when and how to refer the problem to plant maintenance personnel.

5. Laboratory Control Procedures. These include special and routine activities relating to laboratory analysis, the specification of sampling procedures and locations and the general management of the laboratory facilities. For example, the employee would collect primary sludge samples and conduct the analyses.

6. Systems Interaction Procedures. These include activities of the plant employee which relate the functioning of specific units of equipment to other process units and to the system as a whole. For example, the employee would determine how the effective functioning of the primary sludge pumps relates to digester performance.

7. Management/Supervisory Procedures. These include activities relating to employment practices, record keeping, plant operation policy and the establishment of a constructive and realistic rapport between the plant and the community it serves. For example, the employee would keep records on primary sludge pumping, keep an inventory of spare parts and evaluate the adequacy of maintenance procedures by shift personnel.

CURRICULUM DESIGN

After deciding what process equipment an operator must operate and maintain, and finding out what an operator does through the task analysis, they listed the objectives a student must master to successfully operate and manage a treatment plant. For example, the student will describe and perform the normal inspection procedure for the primary sedimentation unit including frequency of inspection, conditions to look for and the actions he should take.

INSTRUCTOR'S GUIDES

The next step was the design of manuals to guide the instructor. In the guides varied learning activities and imaginative innovations which produce more learning than traditional teaching methods are emphasized. The instructional suggestions do not need to be followed slavishly, but should be modified and improved as much as possible.

The instructor's goal is to achieve the objectives of the curriculum by selecting activities which suit the student's needs and help him to master all the information and skills in the course. The most effective learning occurs when the student is a participant in the learning process, not a spectator.

An instructor should use learning activities which approximate the situations which the student will meet *in the treatment plant*. If it is not possible to teach in a treatment plant, *simulated situations* should be set up in the workshop or classroom so that the student can solve rather than discuss problems. *Group discussion* stimulated by *visual materials* is an effective learning technique. Lecturing, however, is inefficient. Because the student is not actively involved during a lecture, the instructor should use lectures sparingly.

Introduction to Modules of Instruction

In this instructor's guide the topics and ideas are presented as a series of modules, organized around the general objectives stated in the course description for Process Interaction found in *Program Implementation Procedures* of the *CEWT Program*. The modules are designed to help the instructor plan a course of study which explains the relationships and functions of the process units in a wastewater treatment plant.

The modules in *Process Interaction for Wastewater Facilities* are for students who have completed prerequisite material in *Volume II* and *Volume III, Plant Operations for Wastewater Facilities* and *Laboratory Control for Wastewater Facilities*. However, the modules can be adapted for courses which upgrade personnel in plant operations and technical supervision. Each module is also designed as a minicourse. Instructors are urged to group the modules to suit their individual curriculum needs and instructional situations.

INSTRUCTIONAL SETTING

During training the student should have access to a 10 mgd wastewater treatment plant. Each module assumes that the composite model plant unit will be used for instruction in the process. If the recommended unit is not available, an alternate process unit may be substituted and the instructional materials adapted. The recommended CMP units and alternate units for all the processes are listed in table 1, page 4. Two modules on sludge dewatering are included because it is impossible for a student to master operation of this process by learning to operate one process unit. Remember, however, that a student will be more adequately prepared to work in almost any treatment plant if he is trained on the CMP unit. When it is not possible to use the recommended unit, students should be informed about the operation and function of the unit and hands-on training should be conducted on the best alternate unit available.

PURPOSE OF THE MODULES

The modules in *Process Interaction for Wastewater Facilities* help the student to learn how to manage the technical supervision of a wastewater treatment plant. At the completion of the course the student will be able to keep a treatment plant operating satisfactorily by synthesizing the information provided in the course material.

STUDENT PREREQUISITES

Completion of Introduction to Environmental Technology, Plant Operations and In-Plant Practicum, Laboratory Control I and II, and courses in applied mathematics and technical report writing qualify the student to enter Process Interaction for Wastewater Facilities. Concurrent

TABLE I

SPECIFIC PROCESS UNITS RECOMMENDED FOR USE IN IMPLEMENTATION OF THE TWO-YEAR POST HIGH SCHOOL WASTEWATER TECHNOLOGY INSTRUCTIONAL PROGRAM

CMP Unit	Process	Recommended Teaching Unit	Alternate Teaching Unit
A	Collection	Combined system with industrial waste	Sanitary system with industrial waste
B	Chlorination	Vacuum chlorinator with automatic feed to pipe, pneumatic control and electric evaporator	Vacuum chlorinator with automatic feed to pipe, electrical control and electric evaporator
N		Vacuum chlorinator with automatic feed to pipe and closed-loop pneumatic control	Vacuum chlorinator with automatic feed to pipe and closed electrical control
C	Screening and Grinding	Mechanically cleaned bubbler control unit with grinder	Mechanically cleaned electrode control unit with grinder
D	Grit Removal	Aerated unit with bucket elevator	Aerated unit with screw conveyor
E	Primary Sedimentation	Rectangular unit with telescopic valve drawoff, density meter time clock and trough with scraper	Circular unit with telescopic valve drawoff, density meter time clock and trough with scraper
F	Trickling Filtration	Rotary distributor, standard rate unit with dosing tank	Rotary distributor, high rate unit
G	Aeration	Diffused air unit with swing-type diffuser producing fine bubbles	Mechanical aeration unit with turbine and sparger
H	Secondary Sedimentation	Circular, peripheral-feed unit with suction	Circular, center-feed unit with suction
I	Pond Stabilization	Aerobic pond	Facultative pond
J	Thickening	Floatation unit with air	Floatation unit with vacuum
K	First Stage Digestion	Fixed cover, gas recirculation unit with external heat exchanger	Floating cover, gas recirculation unit with external heat exchanger

L	Second Stage Digestion	Floating cover unit with gas storage	Fixed cover unit
M	Sludge Conditioning	Chemical conditioning unit with counter-current elutriation	None
O	Sludge Dewatering	Vacuum filter unit with cloth	Vacuum filter unit with coil
O	Sludge Dewatering	Continuous feed centrifuge	None
P	Solids Disposal	Multiple hearth incinerator unit	Fluidized bed incinerator unit
Q	Effluent Disposal	Direct reuse system	Underground disposal system
R	Flow Measurement	Centralized recording and totalizing system including Parshall flume, Venturi meter, magnetic flowmeter and rotameter	None
S	Pumping and Piping	System with magnetically connected, pneumatically controlled, diesel driven, centrifugal pumps; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping	None
T	Electric Power	System using delta transformers, generators, electrical switchgear, automatic gear, automatic circuit actuators on motors and telemetering with alarms	System using Y transformers, generators, electrical switchgear, automatic circuit actuators on motors and telemetering with alarms
U	Gas Power	System with internally produced gas with high pressure tanks and rotary positive displacement compressors	System with internally produced gas with high pressure tanks and reciprocating compressors

courses in Management and Supervision Procedures, Applied Economics and Politics and Applied Psychology and Human Relations are suggested. (See pages 7 to 19 of *Program Implementation Procedures.*)

TERMINAL OBJECTIVE

When the student has completed the modules of instruction in this course, he should be able to:

1. Name the process units which will bring about prescribed changes in a wastestream and describe how these changes are accomplished.

2. Describe the effect of a waste on the operation of a process or on a receiving stream.

3. Describe the purpose of each process unit in a wastewater treatment plant and explain how its function relates to other process units.

4. Name the process units required to accomplish a given effluent quality and prepare flow diagrams of the relationship of treatment processes.

RESOURCES

The listing of instructional resources suggests materials now available to instructors to accomplish the desired performance in the student. The resource numbers referred to in the modules are keyed to *Water Quality Instructional Resources Information System (IRIS)* which is available from:

National Training Center
MOTD/OWPO
US Environmental Protection Agency
Cincinnati, OH 45268
513-684-7501

Suggestions for selecting audio-visual equipment can be found in *Selecting Audio-Visual Equipment* and *Selecting Instructional Media and Instructional Systems* available from:

Middle Atlantic Applied Technology Inst.
Charles County Community College
La Plata, MD 20646

If suitable materials are not available, instructors are urged to develop their own resources.

FORMAT OF THE MODULES

The module begins with a statement of purpose which explains what the student will be studying. Next, code numbers keyed to a computerized list of instructional resources are listed for the instructor's convenience.

Objectives. The objectives bring the student to the performance level required by the terminal objective. The instructor's evaluation of the student is based solely on what is stated in the objective.

A glossary of verbs which follows this introduction defines the verbs used in the objectives so that the instructor is aware of what he is instructing the student to do and so that his evaluation of the student is based solely on what is stated in the objective.

Conditions. The conditions define the circumstances under which the student performs and is evaluated and lists the information, equipment and assistance to which the student will have access. The best available learning and testing conditions should be used. For example, if the student is to be given a process unit, unit components, photographs or diagrams of a unit, the instructor should provide a process unit. If a process unit is not available, he would use components of the unit in combination with photographs of those components which he does not

have available. Line drawings and diagrams should not be used if photographs and manufacturers' illustrations are available. The composite model plant which represents plant sizes from one to 10 mgd contains the recommended process units listed on pages 4 and 5 of this volume.

Acceptable Performance. The acceptable performance expands the objective and details the steps a student must follow to reach the objective. To move on to the next objective the student must score 70% on each step listed under acceptable performance. In this section the instructor will find the main topics of his lesson plan and for the evaluation of the student's performance.

Instructor Activity. The instructor should get to know his class by working with small groups and with each student. He should encourage students to learn from each other as they work together. He should involve the student in the instructional and learning process. Group discussion and interaction should be emphasized. Films, filmstrips, slides, tapes, transparencies and case histories should be used. Instructional activities are paired numerically with student activities.

Student Activity. This is a listing of activities which the student will take part in, in order to accomplish the specified performance.

EVALUATION TECHNIQUE

The instructor may use or adapt the learning activities listed under instructor activity and student activity as evaluation techniques. The technique chosen should reflect what the objective asks the student to do. For example, if a student is asked to *describe*, the evaluation technique is a *description*. The student should be evaluated under the conditions and to the performance level required for each objective.

Glossary of Verbs

The glossary of verbs is included here so that the instructor will know exactly what the student is being asked to do to meet his objective. The list includes all the verbs from the objectives and the acceptable performance sections of all the modules, as well as some verbs used in the instructor and student activities.

	DEFINITION	APPLICATION
CONSIDER	To think about with a degree of attention; to come to view, judge or classify.	Consider the variations in CMP units F, G and H when discussing the effects of the wastes.
CONSTRUCT	To put together a complex of mental images, deliberately synthesized in a form to aid the imagination.	Construct flow diagrams for communities and treatment plants described by the instructor.
DEMONSTRATE	To illustrate or explain in an orderly and detailed way with many examples, specimens and particulars.	Demonstrate the preparation of flow diagrams for different sets of conditions.
DESCRIBE	To represent by words written or spoken for the knowledge or understanding of others; to transmit an image of the identifying features, the nature and characteristics of objects, events and actions.	Describe how the conditions and characteristics of the wastestream are altered by the process units.
DISCUSS	To talk about, to present in detail; to exchange views or information about.	Discuss the conditions and characteristics of the wastestream and the process units which change them.
EXPLAIN	To make plain or clear; to present in detail.	Describe the purpose of each process unit in a wastewater treatment plant and explain how its function relates to other process units.
INDICATE	To state or express without going into detail.	Indicate which of the wastes have these effects on the process units.

	DEFINITION	APPLICATION
LIST	To enumerate or specify.	List the references.
NAME	To supply the correct name, in oral or written form, for an object, class of objects, persons, places, conditions or events which are pointed out or described.	Name the process units which will bring about a prescribed change in a wastestream.
PREPARE	To make ready beforehand for some purpose.	Prepare a table showing how the process units affect the characteristics and conditions of the wastestream.
SELECT	To choose something from a number or group usually by fitness, excellence or other distinguishing feature.	List and select the references and information needed to develop flow diagrams.

Module 1

TREATMENT PROVIDED BY PROCESS UNITS

PURPOSE: In this module the student will learn to describe the interactions between the process units in a wastewater treatment plant and the importance of each process unit in changing wastewater characteristics. READ PAGES 1 TO 10 BEFORE USING THIS MODULE.

RESOURCES: 122 125 141 459 857 886 1931 2057

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OBJECTIVE 1.1: *Name the process units which will bring about prescribed changes in a wastestream and describe how these changes are accomplished.*

CONDITIONS: Given these conditions or characteristics of the wastestream of the composite model plant (CMP) and the concentration or range of values for the conditions or characteristics:

- acidity
- alkalinity
- ammonia nitrogen
- BOD
- calorific value
- chloride
- chlorine demand
- COD
- color
- conductivity
- dissolved oxygen
- fecal coliform
- floating material
- flow
- foam
- gas (CO_2, CH_4, H_2S)
- grease
- grit composition
- ice
- industrial wastes
- Kjeldahl nitrogen
- level
- mean cell residence time
- nitrate nitrogen
- nitrite nitrogen
- odor
- oil
- orthophosphate
- pH
- relative stability
- residual chlorine
- settleable matter
- septic sewage
- sludge age
- sludge density
- sludge density index
- sludge filterability
- sludge volume index

temperature
total coliform
total dissolved solids
total phosphorus
total solids
total suspended solids
total volatile solids
toxic gases
turbidity
velocity
volatile acids
volatile solids

ACCEPTABLE PERFORMANCE: The student will:

Name the CMP process units which will change the conditions or characteristics of the wastestream, including:

acidity which is affected by CMP units A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, R, S, Q
alkalinity which is affected by CMP units I, J, K, L, M, O
ammonia nitrogen which is affected by CMP units E, F, G, I, K, L, Q
BOD which is affected by CMP units B, E, F, G, H, I,. J, L, N, O, Q
calorific value which is affected by CMP unit P
chloride which is affected by CMP units E, Q
chlorine demand which is affected by CMP units B, N, Q
COD which is affected by CMP units B, E, F, G, H, I, J, L, N, O, Q
color which is affected by CMP units A, B, E, F, G, I, Q
conductivity which is affected by CMP unit E
dissolved oxygen which is affected by CMP units A, B, G, H, I, Q
fecal coliform which is affected by CMP units B, F, G, I, N, Q
floating material which is affected by CMP units A, C, D, E, H, I, Q
flow which is affected by CMP units A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V
foam which is affected by CMP units A, B, E, G, I, Q
gas which is affected by CMP units K, L, U
grease which is affected by CMP units A, B, E, H, Q
grit composition which is affected by CMP units D, Q
ice which is affected by CMP units A, C, D, E, F, G, H, I, Q, R, S
industrial wastes which are affected by CMP units A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, S, Q
Kjeldahl nitrogen which is affected by CMP units E, F, G, I, K, L, Q
level which is affected by CMP units A, C, D, E, F, G, H, I, K, L, N, O, R
mean cell residence time which is affected by CMP units G, H

nitrate nitrogen which is affected by CMP units E, F, G, I, Q
nitrite nitrogen which is affected by CMP units E, F, G, I, Q
odor which is affected by CMP units A, B, E, F, G, I, K, L, N, P, Q
oil which is affected by CMP units A, B, E, Q
orthophosphate which is affected by CMP units E, F, G, I, Q
pH which is affected by CMP units A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, R, S, Q
relative stability which is affected by CMP units B, F, G, I, N, Q
residual chlorine which is affected by CMP units N, Q
settleable matter which is affected by CMP units A, D, E, I, Q
septic sewage which is affected by CMP units A, B, D, E, F, G, I, K, Q
sludge age which is affected by CMP unit G
sludge density which is affected by CMP units E, H, J, K, L, M, O, P, Q, R, S
sludge density index which is affected by CMP unit G
sludge filterability which is affected by CMP unit O
sludge volume index which is affected by CMP unit G
temperature which is affected by CMP units A, E, F, I, J, K, L, P
total coliform which is affected by CMP units B, E, F, G, H, I, N, Q
total dissolved solids which are affected by CMP unit Q
total phosphorus which is affected by CMP units E, F, G, I, Q
total solids which are affected by CMP unit Q
total suspended solids which are affected by CMP units D, E, F, G, H, I, Q
total volatile solids which are affected by CMP unit Q
toxic gases which are affected by CMP units A, B, C, K, L, U
turbidity which is affected by CMP units D, E, F, G, H, I, Q
velocity which is affected by CMP units A, B, C, D, E, F, G, H, I, N, R, S
volatile acids which are affected by CMP units K, L
volatile solids which are affected by CMP units K, L, P

Describe how the CMP process units change the conditions or characteristics of the wastestream.

Discuss these variations in CMP unit F:
- high rate filter
- polishing
- roughing
- single stage filter
- standard rate filter
- two stage filter

Discuss these variations in CMP units G and H:
- aerated lagoon
- biosorption
- complete mixed activated sludge
- contact stabilization
- conventional activated sludge
- extended aeration
- Kraus process
- modified high rate activated sludge
- step feed activated sludge
- tapered aeration

INSTRUCTOR ACTIVITY:

1. Discuss the conditions and characteristics of the wastestream and the process units which change them. Present case histories.
2. Describe how the conditions and characteristics of the wastestream are altered by the process units.

STUDENT ACTIVITY:

1. Name the process units which will change the conditions and characteristics of the wastestream.
2. Construct a table showing the wastestream conditions and characteristics and the process units which alter them and describing how changes are brought about.

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Module 2

EFFECTS OF INDUSTRIAL WASTES ON OPERATIONS

PURPOSE: In this module the student will learn to describe the effect of common industrial wastes on the operation of a process unit or on the receiving stream. READ PAGES 1 TO 10 BEFORE USING THIS MODULE.

RESOURCES: 122 125 141 459 857 886 2057

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OBJECTIVE 2.1: *Describe the effect of a waste on the operation of a process or on a receiving stream.*

CONDITIONS: Given resources and a description of these wastes in the wastestream:

- acid
- alkaline
- brewery
- cannery
- cyanide
- dairy
- distillery
- explosive
- flammable
- inorganic solid
- laundry
- meat-packing
- metal
- paper and pulp
- pesticide
- petrochemical
- pharmaceutical
- phenolic
- radioactive
- tannery
- textile
- volatile organic

ACCEPTABLE PERFORMANCE: The student will:

Select the references, including:
- flow diagrams
- industrial waste surveys
- industrial waste texts and journals
- waste treatability studies

Indicate which of the wastes have these effects on the process units, employees and community:
- aesthetic losses
- biological kills
- chlorine demand

corrosion
deposition
economic loss
explosion hazard
health risk
impairment of capacity
loss of biological growth
overload of mechanical equipment
overload of process unit
plugging
recreational losses
slime growths
upset of chemical equilibrium
wear of equipment

Describe the effects of the wastes on the process units, commenting on:

acid wastes as they affect CMP units A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, S
alkaline wastes as they affect CMP units A, F, H, I, K, L, Q
brewery wastes as they affect CMP units A, F, G, I, P, Q
cannery wastes as they affect CMP units A, B, C, D, E, F, G, H, I, K, L, Q
cyanide wastes as they affect CMP units A, B, F, G, I, K, L, N, Q
dairy wastes as they affect CMP units A, B, F, G, I, K, L, Q
distillery wastes as they affect CMP units A, F, G, I, Q
explosive wastes as they affect CMP units A, P
flammable wastes as they affect CMP units A, P
inorganic solid wastes as they affect CMP units A, E, F, G, I, K, P, Q
laundry wastes as they affect CMP units A, F, G, I, Q,
meat-packing wastes as they affect CMP units A, C, D, E, F, G, I, K, L, N, Q, S
metal wastes as they affect CMP units A, E, F, G, I, K, L, Q
paper and pulp wastes as they affect CMP units A, B, C, D, E, F, G, I, K, L, Q
pesticide wastes as they affect CMP units A, F, G, I, K, L, Q
petrochemical wastes as they affect CMP units A, B, E, F, G, I, K, L, Q, P
pharmaceutical wastes as they affect CMP units A, B, F, G, I, K, L, Q
phenolic wastes as they affect CMP units A, B, F, G, I, K, L, N, Q

radioactive wastes as they affect CMP units A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q
tannery wastes as they affect CMP units A, C, D, E, F, G, I, K, L
textile wastes as they affect CMP units A, C, E, F, G, I, K, L, Q
volatile organic wastes as they affect CMP units A, B, F, G, I, K, L, Q

Consider the variations in CMP units F, G and H when discussing the effects of the wastes.

INSTRUCTOR ACTIVITY:

1. Describe the references and how to use them.
2. Describe effects of the wastes on the process units.

STUDENT ACTIVITY:

1. List the references and select the references describing each waste.
2. Construct a table of the wastes and their effects on treatment processes.

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Module 3

RELATIONSHIP OF PROCESS UNITS

PURPOSE: In this module the student will learn about the relationship between process units and how the performance of one unit affects another. READ PAGES 1 TO 10 BEFORE USING THIS MODULE.

RESOURCES: 122 125 141 459 857 886 1931 2057

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OBJECTIVE 3.1: *Describe the purpose of each process unit in a wastewater treatment plant and explain how its function relates to other process units.*

CONDITIONS: Given the process units in the composite model plant (CMP).

ACCEPTABLE PERFORMANCE: The student will:

Discuss the collection of domestic wastewater, floating solids, industrial wastewater and storm water.

Describe the purpose of the process units, commenting on the removal and reduction of:

ammonia nitrogen	Kjeldahl nitrogen
biological solids	nitrate nitrogen
BOD	odor
chlorine demand	phosphorus
coliforms	settleable solids
COD	suspended solids
colloids	total nitrogen
color	total solids
dissolved solids	volatile solids
floating solids	

Discuss production of gas, soil conditioners and reusable water.

Describe how the function of a process unit affects other units, commenting on:

CMP unit A as it relates to units B, C, D, E, F, G, H, I, R, S, Q
CMP unit B as it relates to units E, F, G, I, Q, S
CMP unit C as it relates to units D, E, F, G, I, K, P, Q, S
CMP unit D as it relates to units E, G, H, I, K, L, P, Q, R, S
CMP unit E as it relates to units F, G, H, I, J, K, L, M, O, P, Q, R, S
CMP unit F as it relates to units H, Q, R, S
CMP unit G as it relates to units H, Q, R, S
CMP unit H as it relates to units F, G, J, K, L, M, N, O, P, Q, S
CMP unit I as it relates to units N, Q, R, S
CMP unit J as it relates to units K, L, N, O, P, S
CMP unit K as it relates to units L, S
CMP unit L as it relates to units M, O, P, R, S
CMP unit M as it relates to units O, P, R, S
CMP unit N as it relates to units Q, S
CMP unit O as it relates to units P, S
CMP unit P as it relates to unit S
CMP unit Q as it relates to units B, C, D, E, F, G, H, I, J, K, L, M, N, O
CMP unit R as it relates to units A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, S
CMP unit S as it relates to units A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R
CMP unit T as it relates to units A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S
CMP unit U as it relates to units K, L, S

Discuss the variations in CMP units F, G and H.

INSTRUCTOR ACTIVITY:

1. Describe the effect of the process units on the characteristics and conditions of the wastestream.
2. Describe how a properly operating, a partially operating, or nonoperating process unit affects other units.

STUDENT ACTIVITY:

1. Prepare a table showing how the process units affect the characteristics and conditions of the wastestream.
2. Prepare a table of the effects of a process unit on other process units when it is functioning properly and when it is malfunctioning.

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Module 4

DEVELOPMENT OF FLOW DIAGRAMS

PURPOSE: In this module the student will learn to prepare flow diagrams of process units to meet given treatment requirements. READ PAGES 1 TO 10 BEFORE USING THIS MODULE.

RESOURCES: 122 125 141 459 857 886 2057

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OBJECTIVE 4.1: *Name the process units required to accomplish a given effluent quality and prepare flow diagrams of the relationship of treatment processes.*

CONDITIONS: Given references and information, the process units in the composite model plant, descriptions of the wastes produced by communities with populations of 5,000, 10,000, 25,000, 50,000 and 1,000,000 and the effluent quality required.

ACCEPTABLE PERFORMANCE: The student will:

Select the references and information, including:
- census records
- economic trends
- industrialization plans
- laboratory reports
- NPDES permits
- plant flow data
- population projections
- recreation planning reports
- river basin planning reports
- state stream requirements or effluent requirements
- STORET data
- USGS stream records

Describe the level of treatment needed to produce a given effluent quality, discussing these treatment plants with flows up to 100 mgd:
- primary plant with CMP units A, B, C, D, E, J, K, L, M, N, O, P, Q, R, S, T, U

secondary plant with CMP units A, B, C, D, E, F, H, J, K, L, M, N, O, P, Q, R, S, T, U
secondary plant with CMP units A, B, C, D, E, G, H, J, K, L, M, N, O, P, Q, R, S, T, U
lagoon with CMP units A, I, Q, R, S, T

Prepare a flow diagram, showing the relationship of the units in each treatment plant.

INSTRUCTOR ACTIVITY:

1. Describe the references and information and how to use them.
2. Discuss the level of treatment needed to produce a given effluent quality.
3. Demonstrate the preparation of flow diagrams for different sets of conditions.

STUDENT ACTIVITY:

1. List and select the references and information needed to develop flow diagrams.
2. Describe the level of treatment needed to produce a given effluent quality.
3. Construct flow diagrams for communities and treatment plants described by the instructor.

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